

CHAPTER 1

INTRODUCTION TO PGS

LESSON PLAN 1

METHOD:

Lecture, conference, and demonstration

TIME ALLOTTED:

2.0 hours

COURSE PRESENTED TO:

- a. LAV-25 crews
- b. Instructors
- c. TAVSC personnel

TOOLS, EQUIPMENT, AND MATERIALS (Per Student):

- a. TM 08594A-12&P
- b. Student Handout (Appendix B)

PERSONNEL:

- a. Primary instructor
- b. Assistant instructors

INSTRUCTIONAL AIDS:

- a. Overhead projector
- b. Viewgraphs (Appendix A)

REFERENCES:

- a. TM 08594A-12&P
- b. TM 08594A-10/1A
- c. MCWP 3\1.4.2

APPENDICES:

Appendix A. Viewgraphs
Appendix B. Student Handout

1-1. INTRODUCTION.

(5 minutes)

Note. Show Slide 1.

- a. **Reason.** This lesson provides an overview of the Precision Gunnery System (PGS) for the LAV-25 by discussing the PGS system description, safety regulations, and the general outline of the PGS training course.

Note. Show Slide 2.

- b. **Training Objective.** In a classroom environment, given TM 08594A-12&P and a viewgraph presentation on the safety regulations, a brief PGS description and a general outline of the course, the student will describe verbally the safety regulations, system description and outline of the PGS training course.
- c. **Procedure.** During this block of instruction, using TM 08594A-12&P and viewgraph presentation, we will discuss the purpose, PGS system description, safety regulations, and outline of the PGS training courses.

1-2. LECTURE/CONFERENCE/DEMONSTRATION.

(90 minutes)

Note. Show Slide 3.

- a. **Purpose of Course.**
 - (1) Train LAV-25 crews to use PGS.
 - (2) Teach instructors to conduct PGS training.
 - (3) Train Training Audio Visual Support Center (TAVSC) personnel to troubleshoot and service PGS.

Note. Show Slide 4.

- b. **Presentation of PGS Concept.**
 - (1) **Why PGS?** The high cost of training ammunition, environmental impact, lack of range facilities, and crew turnover have reduced the frequency a LAV-25 crew trains with live ammunition. PGS was developed to provide LAV-25 crews with a tool to train precision, degraded, and battle sight gunnery engagements and conduct force-on-force exercises, without using limited resources.

Note. Show Slide 5.

- (2) **What is PGS?** PGS is a strap-on laser-based training device that allows full crew interaction when conducting precision and battlesight gunnery training. PGS allows the crew to train with all components of the LAV-25 fire control system (FCS).

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

Note. Show Slide 6.

(3) **PGS provides the following features:**

- (a) Full fire control interface
- (b) Replicates 25 mm gun and coax engagements
- (c) Realistic simulation of ballistics and time of flight for AP, HE, and COAX ammunition
- (d) Visual effects (tracer, burst on target) in gunner's and commander's M36/LAV day sights, and DIM36th thermal sight CRT
- (e) Adjustable loading time to replicate the actual upload from hull to turret
- (f) Fully transparent to crew during training
- (g) Sound effects of 25mm gun and coax injected into vehicle intercom

Note. Show Slide 7.

(4) **PGS provides the following training capabilities:**

- (a) Allows crews to engage both stationary and moving targets from a stationary or moving vehicle during panel gunnery or force-on-force exercises
- (b) Can be used for tactical maneuver training including global positioning system (GPS) used to record vehicle position and time data for After Action Review (AAR)
- (c) Provides tracking training mode for manipulation exercises
- (d) Scaled (1/2 and 1/10th) gunnery training capabilities
- (e) Tamper resistant to crew interference
- (f) Full AAR capability
- (g) Programmable ammunition loads

Note. Show Slide 8.

(5) **PGS is compatible with:**

- (a) Tank Weapon Gunnery Simulation System (TWGSS) for M1 tanks
- (b) Precision Gunnery System (PGS) for Bradley Fighting Vehicle and LAV-25s
- (c) MILES systems equipped with retro reflector units
- (d) Panel targets equipped with retro reflector units and/or LTIDs

Note. Show Slide 9.

(6) **PGS consists of three (3) subsystems:**

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

Note. Show Slide 10.

(a) Firing System (FS). Includes the part of the system that simulates the firing of a projectile.

1. Transceiver unit
2. Tracer, burst, obscuration simulator (TBOS)
3. Vehicle interface (vehicle interface unit, expansion unit)
4. Remote system interface (RSI) unit for vehicle position determination and system time synchronization

Note. Show Slide 11.

(b) Target System (TS). Includes the part of the system that simulates the target vehicle's profile and vulnerability when fired upon during force-on-force exercises.

1. Target computer unit
2. Retro detector units
3. Hull defilade detector units

Note. Show Slide 12.

(c) Training Data Retrieval System (TDRS). Includes equipment to perform AAR of PGS training. The AAR equipment consists of a laptop computer with specific AAR software. The laptop computer is also used to program setup data to PGS prior to exercises. The RSI provides the AAR with a map for presentation of vehicle position and training results.

1. TDRS computer unit
2. TDRS memory card

c. **Principles of Operation.**

Note. Show Slide 13.

(1) **Firing simulation.**

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

(a) Ammunition Assignment.

1. Prior to training exercise, the instructor assigns ammunition to the vehicle by programming the TDRS memory card using the TDRS computer unit. The TDRS memory card is inserted into the control panel and when PGS is powered up, the data is downloaded into PGS.
2. The ammunition data contains information on quantity and type of ammunition the system will carry during the training exercise. The ammunition assignment is stored in memory and each time the vehicle fires, the remaining ammunition is decreased.

(b) Ammunition Selection.

1. Ammunition is selected using LAV-25 gunner's or commander's hand control.
2. The firing system also simulates ammunition stored in the hull of the vehicle. PGS simulates the actual upload time to move the ammunition from the hull to the turret. The upload time is adjustable.

(c) Sighting and Firing.

1. Normal turret weapon and sights are used during engagements with PGS. Firing of a simulated round is carried out in the same way as for live firing.
2. PGS is programmed with combat ammunition based upon firing table data and flight dynamics.
3. The correct lead angle and superelevation of the gun must always be applied for a successful engagement.

(d) Projectile Simulation.

1. When a round is fired with PGS, simulation of the projectile begins in the transceiver unit. The purpose of this simulation is to determine the projectile's position in space continuously throughout the time of flight. This is done through ballistic calculations based upon firing table data.
2. Simulation starts in the direction the gun barrel is pointing at the instant a live projectile would have left the muzzle of the gun.
3. The reference direction is used as reference to calculate the position of the projectile during simulation. This direction is gyro stabilized which means that the gun barrel can move without affecting the simulated projectile's position during time of flight.

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

4. Laser light is sent out from the transceiver unit in long, narrow, pulsed beams called lobes. By combining the transmission and reception of laser light within the transceiver unit, the firing system creates something called the flying volume.
5. This flying volume follows the same trajectory the live fired projectile would have taken. It follows the projectile continuously, and the simulated projectile is always in the center of the volume. The flying volume has the same velocity and trajectory as the projectile and is continuously scanned by pulsed laser lobes from the transceiver unit.
6. Gyros in the transceiver unit sense gun barrel movement. During the projectile's time of flight, the transceiver unit calculates the extent to which the gun barrel has moved away from the reference direction. This means that the flying volume's sweep is kept in the same position as at the instant of firing.
7. TBOS units are installed in front of the sights. These units contain a semi-transparent mirror on which the TBOS effects are projected. The gunner and commander see the surrounding terrain through the mirror with the projected TBOS effects.
8. The position of the tracer in the sight is controlled by the projectile trajectory simulation and gyro stabilization. This enables the tracer simulation to have the same trajectory as the simulated projectile. The size of the tracer is reduced as the distance between the projectile and the muzzle increases.
9. If the simulated projectile strikes the target or the ground, there will be burst simulating the impact. The burst on target effect is larger than a burst on ground effect. Different types of ammunition have different sizes of burst effect depending of the capability of that ammunition.

(e) Hit Point Calculated.

1. Hit point determination is carried out when the flying volume covers the target.
2. The transceiver unit, which scans the lobes, provides continuous information about the current position of the lobes. When a reflection is detected by the transceiver unit, the angular position of the lobe is determined. The reference used for this reading is the direction of the simulated projectile at the instant of reflection.
3. The angle that is read is a measurement of the lateral position of the point at which the simulated projectile hits the retro detector unit on the target. By calculating the range in meters to the retro detector unit (target range), the angle can be converted to a hit point (expressed in meters) in relation to the detector.

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

(f) Information Transmission.

1. Hit point information is transmitted to the target vehicle so that the target system, mounted on a target vehicle, can calculate where the hit occurred and the extent of the damage to the vehicle (probability of kill).
2. Hit point information is transmitted in coded form during the intervals between laser lobe pulses. The laser lobes transmit not only hit point information, but also vehicle identity and the type of ammunition fired.

(g) Retro Detectors Evaluated.

1. When a lobe sweeps past a retro detector unit, 6-7 pulses are reflected. The average value of these pulses is calculated and stored in the transceiver unit. During a sweep, a number of reflections from each lobe and each retro detector are averaged and stored. Evaluation is carried out after three sweeps. If all three sweeps contain reflections from the same target, the average value is calculated. The point of impact is checked against a target template.
2. If the point of impact lies within the area covered by the target template, the round is considered as aimed at this target. As a result, the tracer becomes brighter to simulate the projectile's burst, after which the burst is extinguished and the simulation is stopped.
3. If the point of input lies outside the template, the tracer and simulation continue until another target is hit or until the maximum range of the ammunition has been reached. The maximum range corresponds to the maximum range for the ammunition fired, programmed on the TDRS memory card and downloaded into PGS at power up.
4. During table gunnery, the template used to evaluate hit or miss depends on which ammunition type the gunner has fired. For ammunition intended to kill APCs, a BMP front is assumed. For ammunition used to engage troops, a kneeling soldier is assumed. PGS is designed so that the panel target has a retro reflector unit installed in the center of mass.
5. During force-on-force, the system uses the same template to evaluate hit or miss for all ammunition types. The template used compensates for the position of turret-mounted retro detector units in relation to the center of mass of the vehicle. This centers the template around the center of mass of a vehicle.

(h) Miles Code Transmission.

After a completed PGS simulation, the transceiver unit transmits MILES information. If the control panel indicates HIT, the transceiver unit transmits MILES to the target that was hit. This allows PGS to interact with MILES

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

equipped systems and the Laser Target Interface Device (LTID) which causes a target lifting device to drop the panel target when hit with MILES information.

(i) End of Firing System Simulation.

1. After a completed simulation cycle, the result is presented to the commander/crew on the control panel. The result presented indicates an engagement result (HIT, NEAR MISS, GROUND HIT, etc.), impact point, range to target, and ammunition fired.
2. This result, with additional information such as time of round fired, identity of firing system, remaining ammunition, and selected weapon system data, are stored on the TDRS memory card for AAR.
3. The weapon system data contains information such as selected range in weapon system, turret/hull relation, selected ammunition, fired ammunition, etc.

Note. Show Slide 14.

(2) **Target simulation.**

(a) Laser Information Received.

1. Hit point information is detected by the laser detectors in the retro detector units mounted on the vehicle's turret. The retro detector units are mounted in fixed directions around the vehicle, providing 360 coverage. The target computer unit connected to all retro detector units and hull defilade detector units.
2. Before the flying volume, and thus the simulated projectile, reaches the target vehicle, the firing system of the firing vehicle sends out only vehicle ID information data. Nothing is stored as results until an actual hit point is determined. When an actual hit point is determined, this information is stored for evaluation using the TDRS computer unit.

(b) Determine Impact Point.

1. Hit point information, transmitted to the target as a value in relation to the retro detector units, is recalculated by the target computer unit to represent an azimuth and elevation distance in relation to the center of mass of the target vehicle.
2. The target can be hit simultaneously by simulated projectiles from more than one firing vehicle. If this happens, the target computer unit evaluates each impact separately. No accumulative effects are calculated if the same area is hit several times.

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

3. The impact direction is determined by evaluating which of the detectors received the hit point information. Eight detectors, two in each retro detector unit, are used to calculate twelve 30° sectors. Each sector is programmed to represent the target size and vulnerability.
4. If the penetration point is determined to be above the turret/hull rotation point, the direction indicated by the retro detector units is used. If the hit is determined to be below the rotation point, the direction is determined by the hull defilade detector units. If the hit is determined to be below the rotation point (hull) and the hull defilade detector units DO NOT detect any laser light, the hit is determined to be in the berm of a vehicle in defilade position. This vehicle is not killed and can continue to fight.

(c) Hit Vulnerability.

1. The target computer unit uses a template in which the contour of the target is viewed from a particular direction. There are 12 templates, one for each of the 12 impact direction sectors.
2. The templates consist of a grid made up of small squares. Each of these squares provides information of the probability of kill of the target for each type of ammunition used. This information is used to calculate the kill probability of each round impact.

(d) Evaluation of Kill.

1. Once a hit is determined, a random number between 1% and 100% is generated. If this number is lower than the probability of kill determined for the impact point, the target vehicle is killed. If the random number is higher than the probability of kill for the impact point, the target vehicle indicates HIT, WEAPON KILL, or MOBILITY KILL.
2. The purpose of the random number is to make the simulation more realistic since a highly effective hit will usually, but not always, destroy a vehicle. Similarly, an ineffective hit will sometimes destroy a vehicle.

(e) End of Target System Simulation.

1. After a completed simulation cycle, the result is presented on the control panel. The result indicates kill probability (NEAR MISS, HIT, MOBILITY/WEAPON KILL, and KILL), impact angle, and impact point.
2. NEAR MISS is indicated by two flashes from the retro detector unit strobe light.
 - a. A hit that does not kill is indicated by four to six strobe light flashes.

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

- b. A hit that kills a vehicle is indicated by continuous strobe light flashes. A killed vehicle cannot resume fighting until the system has been reset by an instructor using the control gun.
 - c. If MOBILITY KILL is presented on the control panel, the crew must stop the vehicle within 30 seconds or catastrophic KILL will be indicated.
- 3. This target result indication, with additional information such as time of impact and identity of attacker, is stored on the TDRS memory card for AAR.
- 4. Weapon system data such as selected range in weapon system, turret/hull relation, selected ammunition, fired ammunition, etc. is also stored on the TDRS memory card for AAR.

Note. Show Slide 15.

d. General Safety Requirements.

- (1) Mount and dismount vehicle over left front or through the back hatch.
- (2) Maintain three (3) points of contact while on top of vehicle.
- (3) Follow unit SOP for smoking near vehicle.
- (4) Do not go over or under the gun barrel.
- (5) Set DRIVE SELECT LEVER to MANUAL and TURRET DRIVE LOCK to LOCKED.
- (6) Ensure the vehicle MASTER SWITCH is OFF before installing/removing PGS.
- (7) Ensure turret power is OFF (TM 08594A-10/1A, paragraph 2-56).
- (8) Ensure that the AP and HE feed shaft stop knobs on the main gun feeder are pushed in to prevent cables from being snagged and damage to vehicle electronics.

Warning. Transceiver unit has an eye-safety classification of 3A. During operation, DO NOT view transceiver unit with an unaided eye for an extended period of time. DO NOT AT ANY TIME view transceiver unit with an aided eye, i.e., optics which magnify from a distance less than 25 m.

Note. Show Slide 16.

- (9) LASER SAFETY: Do not view transceiver unit with optics from a distance of 25 m or closer.

1-2. LECTURE/CONFERENCE/DEMONSTRATION (Con't).

Note. Show Slides 17 and/or 18. (Use only Slide 17 for crew training.)

e. Training Course Outline.

(1) The course has 14 lessons. The first nine are intended for crews, instructors, and TAVSC personnel. The additional lessons are intended for instructors, Master Gunners, and TAVSC personnel only.

- (a) Introduction to PGS
- (b) Preparation of LAV-25
- (c) Preparation for Operation (PMCS)
- (d) Installation of PGS
- (e) Startup and Alignment
- (f) Operation of PGS
- (g) Post Operational Procedures
- (h) Troubleshooting
- (i) Preparation of Targets
- * (j) Operation of Control Gun (CGUN)
- * (k) Training Data Retrieval System (TDRS) Computer Unit
- * (l) Setup
- * (m) AAR List
- * (n) AAR Map

(*Instructors, Master Gunners, and TAVSC personnel only)

(2) The training course can be tailored to individual unit's needs based on time available and proficiency level of personnel receiving training.

1-3. FINAL REVIEW. (5 minutes)

a. Student Questions.

Note. Show Slide 19.

b. Summary of Main Teaching Points.

- (1) Purpose of Course
- (2) Presentation of PGS concept
- (3) General safety regulations
- (4) Training course outline

Note. Show Slide 20.

1-3. FINAL REVIEW (Con't).

- c. **Closing Statement.** This block of instruction has prepared you to understand the concept of PGS and the safety procedures pertaining to its operation. The knowledge gained in this lesson will provide the foundation for future lessons presented in the training course.

**APPENDIX A
TO LESSON PLAN 1**

INTRODUCTION TO PGS

VIEWGRAPHS

APPENDIX B TO LESSON PLAN 1

INTRODUCTION TO PGS

STUDENT HANDOUT

B-1. PURPOSE OF PGS.

- a. The PGS is a vehicle-mounted training device that aids the crew in gaining and improving proficiency in gunnery skills without the expenditure of live ammunition.
- b. Gunnery and tactical training can be conducted anywhere that eye-safe laser firing is permitted.
- c. PGS provides the crew with visual and sound effects that accurately simulate live firing conditions.

B-2. FUNCTIONAL CONFIGURATION.

- a. PGS simulates the firing of the LAV-25's 25 mm gun, the firing of the coaxially-mounted machine gun, and the effects of a target vehicle being hit.
- b. PGS consists of three subsystems: firing system, target system, and Training Data Retrieval System (TDRS).
 - (1) **Firing system.** PGS simulates the firing ballistic characteristics of ammunition and the visual and sound effects of firing.
 - (2) **Target system.** The target system receives firing information from an attacking weapon system, equipped with a laser training device, and notifies the crew of the effects of the attack. The attack could come from another PGS-equipped vehicle, a Tank Weapon Gunnery Simulation System (TWGSS)-equipped tank, or a Multiple Integrated Laser Engagement System (MILES)-equipped unit. An instructor using the control gun (CGUN) can also communicate with the PGS target system.
 - (3) **TDRS.** The TDRS is used to evaluate the effectiveness of the firing engagements whether in a precision gunnery exercise or a tactical training environment. The TDRS provides real time analysis for each round fired and engagement undertaken. For more information on TDRS, refer to TM 9-6920-711-12&P-1.

B-3. FEATURES AND CAPABILITIES.

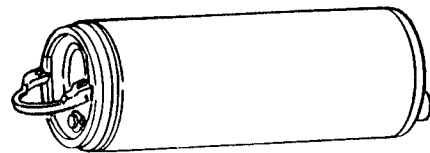
- a. PGS simulates the vehicle firing and ammunition effect on targets.
- b. Provides full fire control interface to enable the vehicle crew to train using normal engagement techniques.

B-3. FEATURES AND CAPABILITIES (Con't).

- c. Provides training capabilities utilizing Class 3A (conditionally eye-safe) eye-safe lasers.
- d. Interoperable and compatible with TWGSS, MILES, and Laser Target Interface Device (LTID).
- e. Provides panel gunnery training, target tracking training, scale target capability, and combat training in a realistic environment with immediate feedback.
- f. Simulates the visual effects of the 25 mm gun and the coaxially-mounted machine gun. These simulations include tracer, tracer burst on target, and burst on ground.
- g. Provides firing sound effects over vehicle intercom. These sound effects include:
 - (1) 25 mm gunfire signature
 - (2) Coax gunfire signature
 - (3) Near Miss, Hit or Kill indication
 - (4) System error indication
- h. The RSI continuously logs vehicle location data and time information.

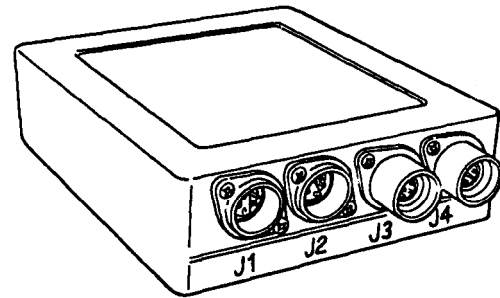
B-4. DESCRIPTION OF MAJOR COMPONENTS.

a. **Transceiver Unit.** Performs the complete weapon effect simulation. The unit is preprogrammed with the physical and operational characteristics of the weapon it is simulating and utilizes lasers to transmit pulses and receive reflections from the targets. The unit determines target position from the laser pulses and transmits the point of impact, type of ammunition, and identity of attacker to the target. MILES information is also transmitted in order for MILES-equipped target systems to respond.

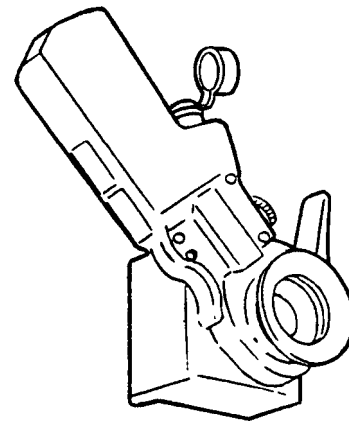


B-4. DESCRIPTION OF MAJOR COMPONENTS (Con't).

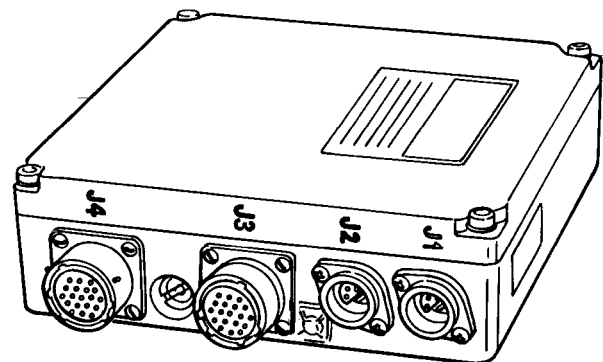
b. **TBOS Driver Unit.** Provides tracer and burst effects simulation into the gunner's and commander's TBOS eyepiece units.



c. **TBOS Eyepiece Unit.** Provides tracer and target effects simulation into the gunner's and commander's day sight pictures.

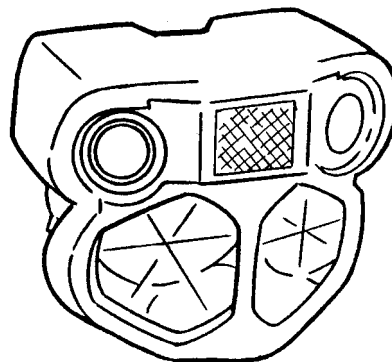


d. **Target Computer Unit.** Receives results of a simulated firing, including hit point, type of ammunition, and identity of attacker. The unit compares this information with the type of target it is programmed to simulate, its size and vulnerability, and determines if there was a near miss, hit, mobility kill, weapon kill, catastrophic kill, or no effect. The target system is also programmed to detect firing from MILES-equipped firing systems.

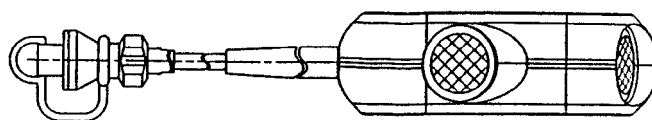


B-4. DESCRIPTION OF MAJOR COMPONENTS (Con't).

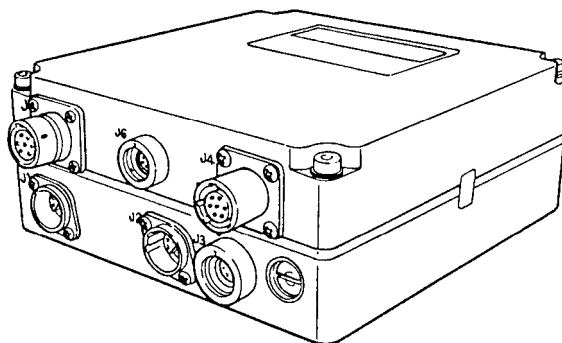
e. **Retro Detector Unit.** Consists of two retro reflectors, two laser detectors, and one strobe light. The reflectors reflect laser pulses back to the attacking PGS, TWGSS or MILES. The laser detectors receive hit information, including type of ammunition, identity of attacker, and hit point from attacking PGS or TWGSS. The strobe light flashes when a vehicle has been hit. Four units are placed high on the turret to provide 360 degrees of coverage.



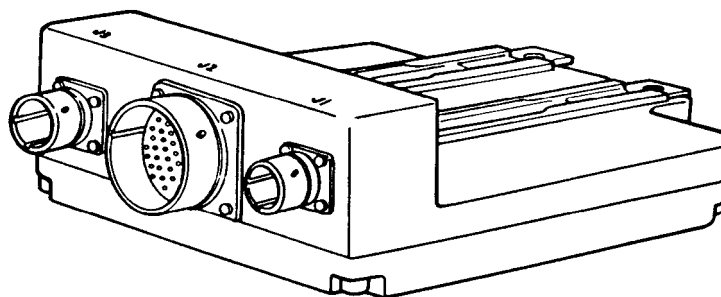
f. **Hull Defilade Detector Unit.** Senses hit to hull of vehicle, when vehicle hull is exposed. Four units are placed low on the turret to provide 360 degrees of coverage.



g. **Vehicle Interface Unit.** Receives electrical power from the vehicle and distributes power to system components.

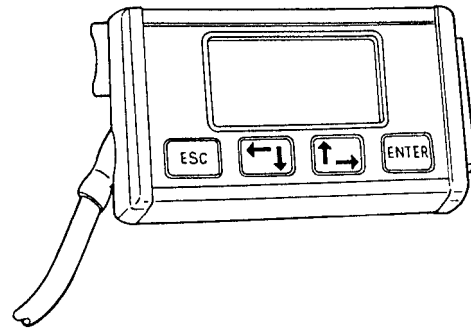


h. **Expansion Unit.** Receives information from the vehicle regarding turret position and vehicle fire control system status. Receives and sends signals to vehicle fire control system, and provides this information to the vehicle interface unit. Also provides audio indications to the vehicle intercom.

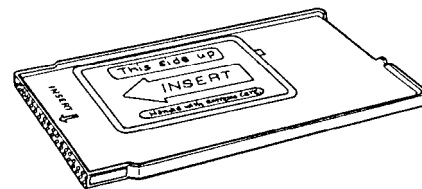


B-4. DESCRIPTION OF MAJOR COMPONENTS (Con't).

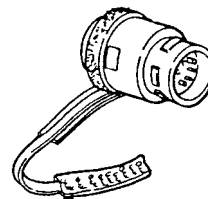
i. **Control Panel.** Provides the means to manually input required system functions, subfunctions, and options; upload ammo; select training modes; operate system during training; align system prior to training; and view results of firing simulations and BIT error messages.



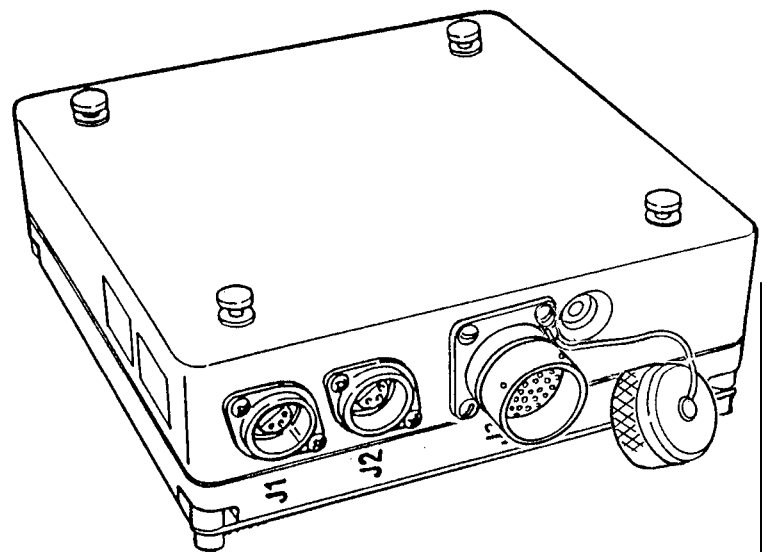
j. **TDRS Memory Card.** Stores firing and target vehicle application data needed for the intended training exercise. Collects and stores exercise events collected during PGS training. The stored training exercise events can be retrieved for After Action Review (AAR) with the TDRS computer unit.



k. **Shorting Plug.** Provides a simulated firing of the 25 mm gun by isolating the 25 mm gun from its firing circuits.



l. **TBOS Video Mixer Unit.** Mixes video-generated tracer and target effects images into the HIRE sight.



B-4. DESCRIPTION OF MAJOR COMPONENTS (Con't).

m. **Remote System Interface (RSI) Unit.**

Receives satellite signals that continuously calculate vehicle position. Provides a means to view and store the vehicle position during a training exercise. The stored vehicle position(s) and time data can be retrieved for AAR with the TDRS computer unit.

